

**USAARL REPORT NO. 82-10**



**CATHODE-RAY-TUBE RASTER LINE SELECTOR  
WITH HORIZONTAL MODULATION CAPABILITY**

**John H. Hapgood  
and  
Clarence E. Rash**

**RESEARCH SYSTEMS DIVISION  
SENSORY RESEARCH DIVISION**

**September 1982**

**U.S. ARMY AEROMEDICAL RESEARCH LABORATORY  
FORT RUCKER, ALABAMA 36362**

**USAARL**

## NOTICE

### Qualified Requesters

Qualified requesters may obtain copies from the Defense Documentation Center (DDC), Cameron Station, Alexandria, Virginia. Orders will be expedited if placed through the librarian or other person designated to request documents from DDC.

### Change of Address

Organizations receiving reports from the US Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.


### Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

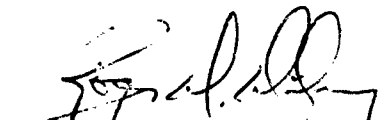
### Disclaimer


The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Reviewed:

  
Frank E. Chapple, III, LTC, VC  
Director, Research Systems Division

Released for Publication:

  
Roger W. Wiley, LTC, MSC  
Chairman, Scientific Review  
Committee

  
DUDLEY R. PRICE  
Colonel, MC  
Commanding

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER USAARL Report No. 82- 10	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle)  CATHODE-RAY-TUBE RASTER LINE SELECTOR WITH HORIZONTAL MODULATION CAPABILITY		5. TYPE OF REPORT & PERIOD COVERED  Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)  John H. Hapgood Clarence E. Rash		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS  US Army Aeromedical Research Laboratory Fort Rucker, AL 36362		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  64207.A, 4E464207D425, 00,048
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Medical Research & Development Command Fort Detrick Frederick, MD 21701		12. REPORT DATE September 1982
		13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)  Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Raster Line Selector Cathode-Ray-Tube Modulation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  A simple and inexpensive circuit which provides a method of selecting the number and position of active raster lines visible on a CRT display is presented. Requiring inputs of vertical drive and horizontal and vertical sync signals, the circuit produces an output which can be fed directly into the video input of the display.		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

## TABLE OF CONTENTS

	<u>Page No.</u>
List of Illustrations . . . . .	3
Introduction . . . . .	5
Circuit Description for Raster Line Selector. . . . .	5
Circuit Description for Raster Line Selector with Horizontal Modulation Capability . . . . .	7
Discussion . . . . .	8
Appendix List of Components . . . . .	11

## LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page No.</u>
1	Schematic for Raster Line Selector Circuit. . . . .	6
2	Actual Waveforms for Test Points A - D. . . . .	7
3	Schematic for Raster Line Selector Circuit with Horizontal Modulation Capability . . . . .	8
4	Photographs of Actual Raster Demonstrating Circuit Capabilities. . . . .	9

## INTRODUCTION

With the increased usage of cathode-ray-tube (CRT) displays in the areas of target detection and recognition, a greater emphasis has been placed on the ability to measure the image quality of these displays. Much of this effort has been restricted to determining the image quality for static targets. Only recently has attention been focused on dynamic imagery, that is, imagery resulting from relative target/sensor motion.

The US Army Aeromedical Research Laboratory (USAARL) has been investigating the parameters of CRT displays which affect the imaging of targets in motion and techniques that can quantify the image degradation resulting from this motion. In the attempt to develop methods and instrumentation to aid in this investigation, it was decided to enhance the normally available control of the individual raster lines of the CRT display.

To reach this goal, a circuit was developed which provides a simple method of selecting the number and position of active raster lines on the CRT display. The circuit development was actually accomplished in two stages. First, a circuit was developed which allowed the selection of the number of active raster lines and their position. In the second stage, the capability to modulate these lines horizontally was added.

## CIRCUIT DESCRIPTION FOR RASTER LINE SELECTOR

The circuit shown in Figure 1\* allows the user to select from zero to five active lines and control the vertical position at which they occur on the display. The required inputs are a negative-going vertical blanking signal and horizontal and vertical synchronization pulses.

The active lines are written at the frame rate. In other words, the standard interlacing method of presenting two alternating active fields is defeated. This is accomplished by blanking the electron beam on alternating fields. The number of active lines is controlled by the width of a pulse which turns on the electron beam. The time at which the beam is turned on, referenced to the active field's vertical sync pulse, determines the positioning of the active lines.

---

\* Component values are given in Appendix .

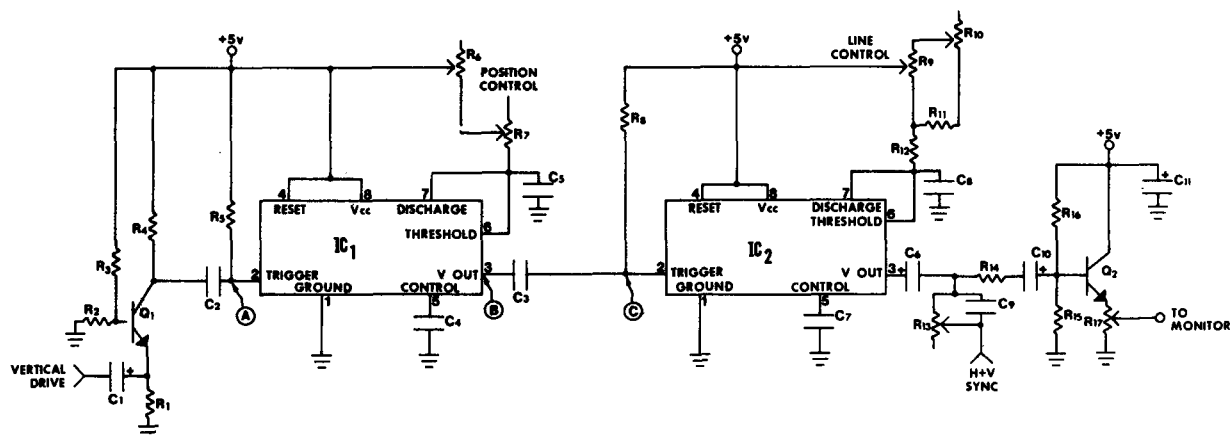


Figure 1. Schematic for raster line selector circuit.

The vertical drive pulses are applied through coupling capacitor  $C_1$  to the emitter of transistor  $Q_1$  which is operating as a common-base amplifier. The amplification insures that the pulses will be of sufficient driving amplitude when they arrive at pin 2 of  $IC_1$ . The amplified vertical drive pulses are taken off of the collector of  $Q_1$  and differentiated by coupling capacitor  $C_2$  and resistor  $R_5$  before being fed into the TRIGGER pin (pin 2) of  $IC_1$ .  $IC_1$  is a 555 timer configured as a monostable multivibrator (one shot). The pulse width of the output pulses available on pin 3 is controlled by capacitor  $C_5$  and the control potentiometer  $R_6$  in combination with  $R_7$ . This potentiometer positions the active raster lines on the display. Actual waveforms present at test points A and B, noted on the schematic, are shown in Figure 2. The differentiated pulses at test point A have a period of 17 msec. The pulses at pin 3 of  $IC_1$  (test point B) can vary in width between 17 and 33 msec. This pulse makes its high to low transition during alternate fields. Where this transition occurs within the field determines the location of the active lines within the field.

The output from pin 3 on  $IC_1$  is differentiated by the RC combination of coupling capacitor  $C_3$  and resistor  $R_8$ . The resulting pulses are fed to the TRIGGER input (pin 2) of  $IC_2$ , which is also a 555 timer used in a monostable multivibrator configuration. The timing period of  $IC_2$  is controlled by capacitor  $C_8$  and the control potentiometer  $R_9$ . Adjusting  $R_9$ , which varies the pulse width of the output of  $IC_2$ , selects the number of lines which will be active on the display. For the values indicated, up to five consecutive lines may be selected, requiring a pulse width of from 0 to 315  $\mu$ sec. Waveform C (from test point C) is shown in Figure 2.

The output from pin 3 of  $IC_2$  is then combined with the horizontal and vertical sync pulses and applied to the base of transistor  $Q_2$  which acts as an emitter follower. The final output, taken off of potentiometer  $R_{17}$ , can be fed directly into a 75 ohm input on the display.

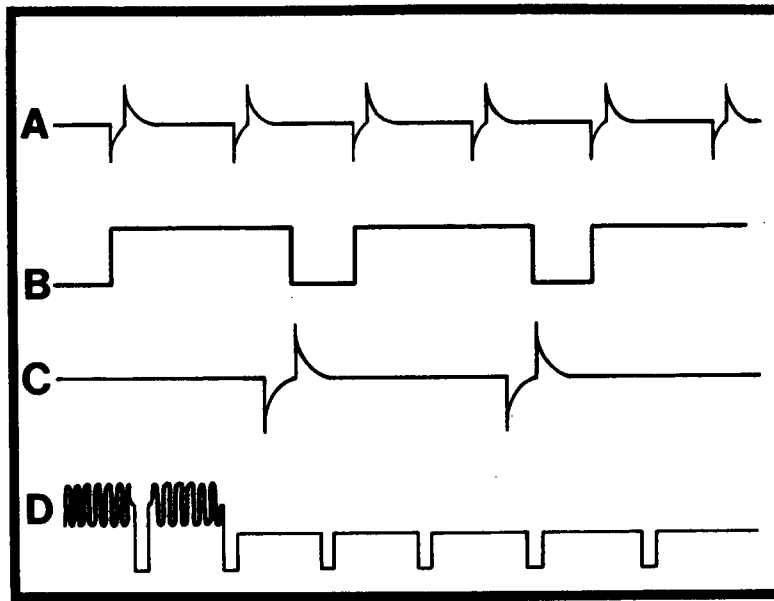


Figure 2. Actual waveforms for test points A - D.

#### CIRCUIT DESCRIPTION FOR RASTER LINE SELECTOR WITH HORIZONTAL MODULATION CAPABILITY

In order to provide for the capability of modulating the active horizontal raster lines, the previously developed circuit was slightly modified. The new schematic is shown in Figure 3.\* The input of the horizontal and vertical sync pulses was moved to the base circuit of the third stage ( $Q_5$ ) of an added three-stage amplifier. The desired modulating signal is input to the emitter of the first stage ( $Q_3$ ). The first and second stages are a common-emitter configuration; the third stage is configured as an emitter-follower.

The modulation occurs in the transistor  $Q_3$ . The pulse which arrives at the base of  $Q_3$  has a pulse width equal to  $\sim 53 \mu\text{sec}$ , or a multiple thereof, the time required for one (or more) horizontal line scan. Transistor  $Q_3$  will have a change in its collector (output) voltage only when the base voltage, i.e., the pulse amplitude, exceeds 0.6v. The signal applied to the emitter of  $Q_3$  will have an effect on the collector (output) voltage only when  $Q_3$  has been turned on. The resulting signal will be modulated pulses of width equal to the horizontal line scan period. The waveform representing this signal (at test point D in Figure 3) is shown in Figure 2.

\* Component values are given in Appendix A.

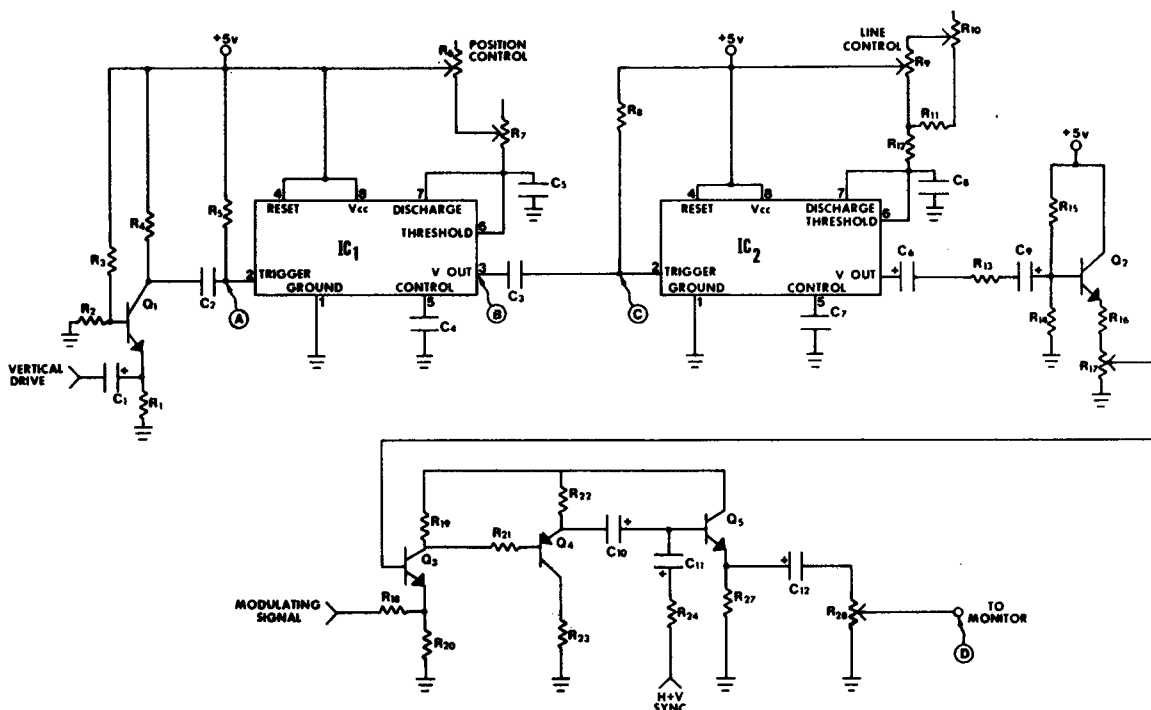
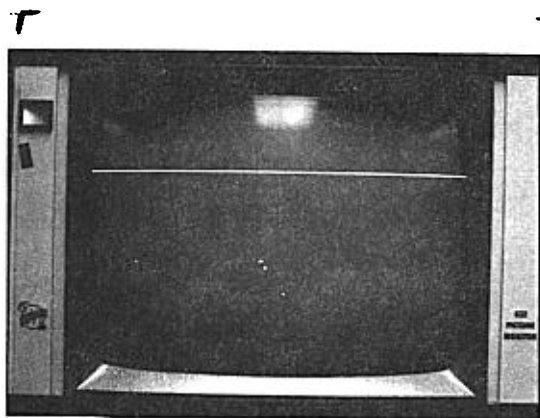


Figure 3. Schematic for raster line selector circuit with horizontal modulation capability.

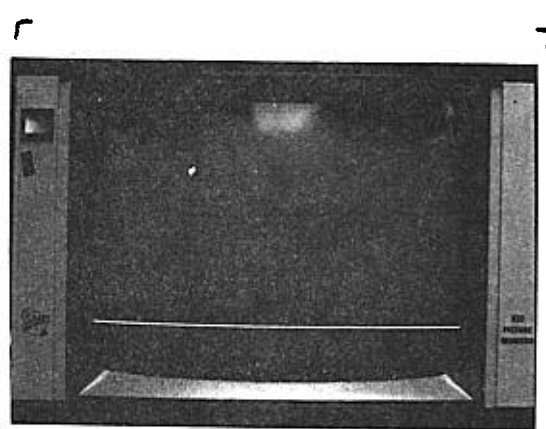
## DISCUSSION

The capabilities of the final circuit (in Figure 3) are demonstrated in the actual display photographs presented in Figure 4. As shown, the number of active lines can be varied, and the location of the active lines can be anywhere on the raster. The number of active lines available for the circuit described is from zero to five. If more lines are required, suitable substitutions for capacitor  $C_6$  and the resistor network  $R_9$ - $R_{12}$  (Figure 3) can be made.

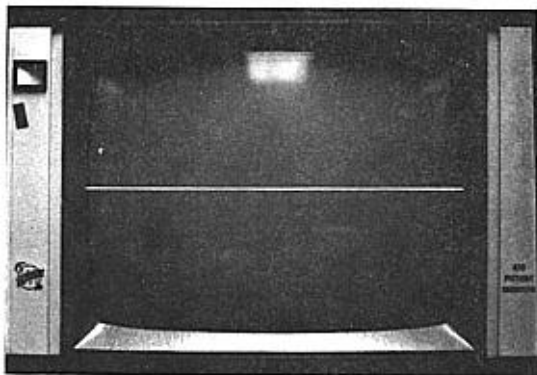
The ability to reduce the number of raster lines to one and position this line anywhere on the display will simplify the analysis of pixel response by removing the additional PMT response from preceding and succeeding lines. Single line modulation transfer function analysis may also be enhanced by the ability of this circuit to produce a single modulated line.



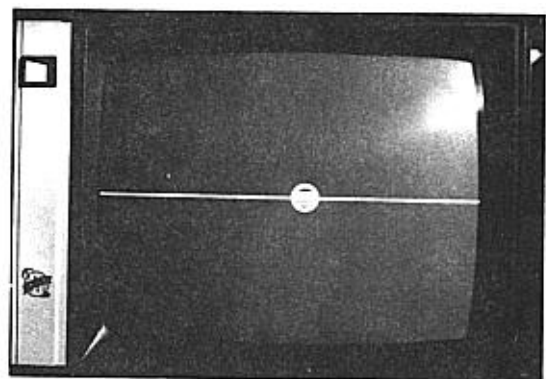
(a)



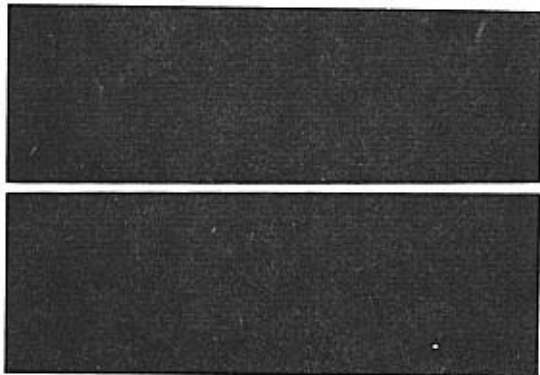
(b)



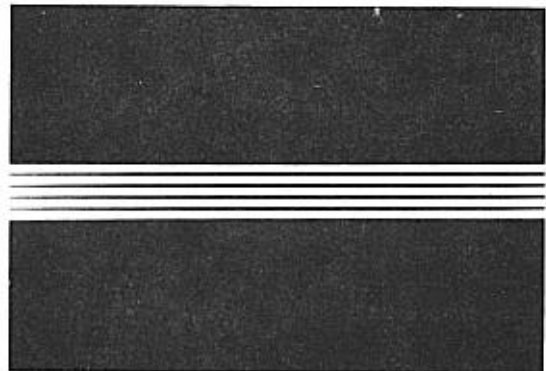
(c)



(d)



(e)



(f)

FIGURE 4. Photographs of actual rasters demonstrating circuit capabilities.  
 (a and b) Location of active lines can be seen anywhere on display.  
 (c and d) The number of raster lines can vary.  
 (e and f) Close-up view of actual raster with single and multiple active lines.

APPENDIX  
LIST OF COMPONENTS

FOR FIGURE 1

INTEGRATED CIRCUITS

IC<sub>1</sub>, IC<sub>2</sub> - 555 Timer

RESISTORS\*

R<sub>1</sub> - 270  $\Omega$   
R<sub>2</sub> - 2.2K  $\Omega$   
R<sub>3</sub>, R<sub>5</sub>, R<sub>8</sub> - 22K  $\Omega$   
R<sub>4</sub>, R<sub>14</sub> - 1K  $\Omega$   
R<sub>6</sub> - 400K  $\Omega$   
R<sub>7</sub> - 2M  $\Omega$   
R<sub>9</sub>, R<sub>10</sub> - 100K  $\Omega$   
R<sub>11</sub> - 62K  $\Omega$   
R<sub>12</sub> - 21K  $\Omega$   
R<sub>13</sub> - 5K  $\Omega$   
R<sub>15</sub> - 6.8K  $\Omega$   
R<sub>16</sub> - 20K  $\Omega$   
R<sub>17</sub> - 500  $\Omega$

TRANSISTORS

Q<sub>1</sub>, Q<sub>2</sub> - 2N3904

CAPACITORS

C<sub>1</sub>, C<sub>6</sub>, C<sub>11</sub> - 100  $\mu$ f, 10 VDC, electrolytic  
C<sub>2</sub>, C<sub>3</sub>, C<sub>9</sub> - .001  $\mu$ f  
C<sub>4</sub>, C<sub>7</sub> - .01  $\mu$ f  
C<sub>5</sub> - .039  $\mu$ f  
C<sub>8</sub> - .0019  $\mu$ f  
C<sub>10</sub> - 200  $\mu$ f, 16 VDC, electrolytic

FOR FIGURE 2

INTEGRATED CIRCUITS

IC<sub>1</sub>, IC<sub>2</sub> - 555 Timer

RESISTORS\*

R<sub>1</sub>, R<sub>20</sub> - 270  $\Omega$   
R<sub>2</sub> - 2.2K  $\Omega$   
R<sub>3</sub>, R<sub>5</sub>, R<sub>8</sub> - 22K  $\Omega$   
R<sub>4</sub>, R<sub>13</sub>, R<sub>21</sub>, R<sub>24</sub> - 1K  $\Omega$   
R<sub>6</sub> - 400K  $\Omega$   
R<sub>7</sub> - 2M  $\Omega$   
R<sub>9</sub>, R<sub>10</sub> - 100K  $\Omega$   
R<sub>11</sub> - 62K  $\Omega$   
R<sub>12</sub> - 21K  $\Omega$   
R<sub>14</sub> - 6.8K  $\Omega$   
R<sub>15</sub> - 20K  $\Omega$   
R<sub>16</sub> - 2K  $\Omega$   
R<sub>17</sub>, R<sub>28</sub> - 500  $\Omega$   
R<sub>18</sub> - 300  $\Omega$   
R<sub>19</sub> - 4.7K  $\Omega$   
R<sub>22</sub> - 150  $\Omega$   
R<sub>23</sub> - 3.3K  $\Omega$   
R<sub>25</sub> - 10K  $\Omega$   
R<sub>26</sub> - 47K  $\Omega$   
R<sub>27</sub> - 470  $\Omega$

TRANSISTORS

Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>, Q<sub>5</sub> - 2N3904  
Q<sub>4</sub> - 2N3906

CAPACITORS

C<sub>1</sub>, C<sub>6</sub> - 100  $\mu$ f, 10 VDC, electrolytic  
C<sub>2</sub>, C<sub>3</sub> - .001  $\mu$ f  
C<sub>4</sub>, C<sub>7</sub> - .01  $\mu$ f  
C<sub>5</sub> - .039  $\mu$ f  
C<sub>8</sub> - .0019  $\mu$ f  
C<sub>9</sub> - 200  $\mu$ f, 16 VDC, electrolytic  
C<sub>10</sub>, C<sub>11</sub> - 10  $\mu$ f, 50 VDC, electrolytic  
C<sub>12</sub> - 47  $\mu$ f, 16 VDC, electrolytic

\*All fixed resistors are 10%, 1/4-watt.